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THE EFFECTS OF POLLUTION CONTROL ON THE NONFERROUS METALS INDUSTRIES

ALUMINUM

Part I

Introduction and Executive Summary

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Submitted to
The Council on Environmental Quality
Executive Office of the President
Washington, D.C.

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CHARLES RIVER ASSOCIATES INCORPORATED · CAMBRIDGE, MASSACHUSETTS

December 1971

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CHARLES RIVER ASSOCIATES INCORPORATED

THE ECONOMIC EFFECTS OF POLLUTION CONTROLS ON THE NONFERROUS METALS INDUSTRY: ALUMINUM

Prepared for
the Council on Environmental Quality

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December 1971

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PREFACE

This report on the economic effects of pollution controls on the aluminum industry has been organized into three parts comprised of eight chapters. The three parts can be read separately or in conjunction with one another. Part I summarizes the contents of the succeeding two parts, providing a broad profile of the aluminum industry and outlining the economic effects of pollution controls on the industry. The important points and conclusions of the full report are contained in the first part, with greater detail and analysis in the following two parts.

Part II comprises separate chapters on:

- Trends in supply and the technology of production
- Consumption
- Structure of the industry
- Prices
- Government policies
- The aluminum industry in the United States

Part III is our detailed analysis of the economic effects of imposing pollution controls on the aluminum industry.

Much of the information contained here was first published in Charles River Associates Incorporated, *An Economic Analysis of the Aluminum Industry* (Cambridge, Mass., March 1971), which we prepared under contract with the General Services Administration. Data presented in this report if not otherwise attributed is taken from our GSA report.

PART I

Chapter 1

INTRODUCTION AND EXECUTIVE SUMMARY

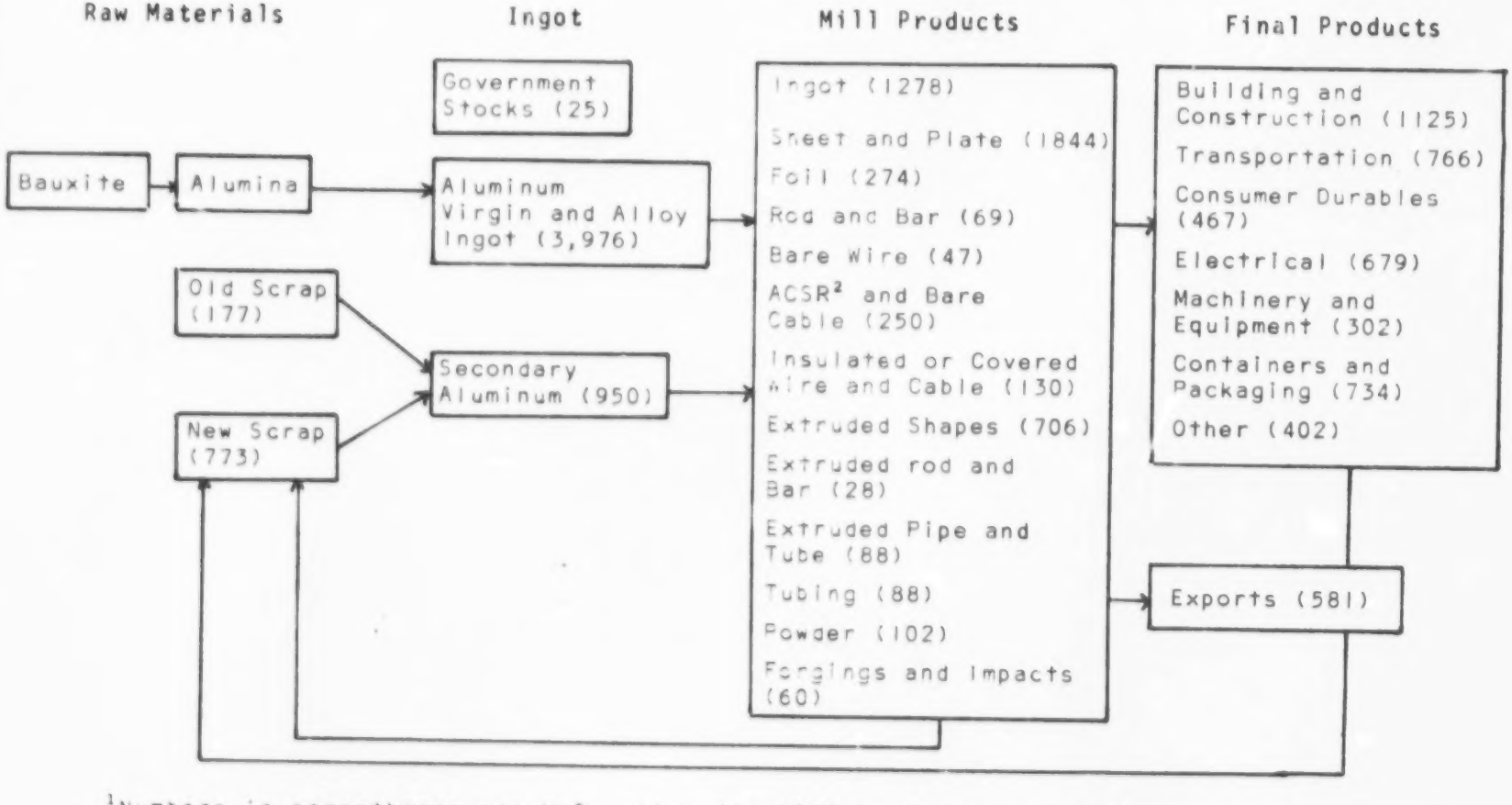
Overview of the Aluminum Market

The aluminum market throughout the twentieth century has been characterized by spectacular, steady growth, and the postwar period has been no exception. For example, between 1947 and 1970, U.S. primary production grew almost seven-fold (from 572,000 short tons to 3,976,000 short tons) and total noncommunist production grew almost nine-fold (from 1,053,000 short tons to 8,822,000 short tons).

As Figure 1-1 shows, aluminum passes through three stages from ore to metal: bauxite, alumina, and primary aluminum. Shipments to consumers include ingot and mill products produced from both primary and secondary aluminum. Secondary smelters purchase new and old scrap as their principal source of supply and produce ingot for foundries and other applications. In 1970, U.S. primary production was 3,950,000 tons and secondary production was 950,000 tons (773,000 tons from old scrap and 177,000 tons from new scrap).

Figure 1-1

FLOW CHART OF THE ALUMINUM MARKET[1]



[1]Numbers in parentheses are U.S. value for 1969 in thousands of short tons.

[2]Aluminum Cable, steel reinforced.

SOURCE: Data from the Aluminum Association, *Aluminum Statistical Review 1969*, New York, N.Y., 1969.

Aluminum ingot is either sold for direct use in foundries or is fabricated into mill products, such as sheet and plate (1,844,000 tons in 1970), foil (279,000 tons) and wire (427,000 tons). The major markets for aluminum in the United States are building and construction (1,125,000 tons), transportation (766,000 tons), electrical (679,000 tons), containers and packaging (734,000 tons), consumer durables (467,000 tons), machinery and equipment (302,000 tons).

Chapters 2 through 7 of this report present in detail those aspects of the aluminum market that are summarized below.

Technology of Production

Primary aluminum production is divided into three stages: bauxite mining, alumina production, and the reduction of alumina to aluminum. The last stage accounts for about two-thirds of the average cost per ton of primary aluminum. The three stages tend to occur in different locations and have different technologies and cost functions.

The most important bauxite-producing nations are Jamaica, Surinam, Australia, and Guyana, with only small quantities produced in the United States. While bauxite is widely dispersed in the earth's crust, rich bauxite deposits are relatively scarce. For most integrated producers, bauxite represents about 5 to 10 percent of the total costs of producing aluminum.

Although there has been a steady increase in productivity over the past two decades in alumina and aluminum production, the basic processes used for manufacturing these products have been unchanged since the

19th Century. The probable outlook for the next decade is that the prevailing raw materials and processes for producing aluminum ingot will continue to be used, with gradual improvements in efficiency.

Alumina is produced from bauxite by the Bayer process. Because of the over 50 percent weight reduction in producing alumina from bauxite, there has been a marked trend to locate alumina facilities near the bauxite mines. The minimal efficient scale of such an operation may be as much as 600,000 tons per year (of alumina), with an initial capital investment of as much as $200-300 million. Average production costs at an efficient plant are about $72 per ton (in 1970 dollars, assuming normal capacity utilization), of which about two-thirds are variable costs and one-third are fixed costs.[1]

Aluminum plants tend to be located near major markets and low-cost power supplies. The major producing countries in 1970 were the United States (45 percent of total noncommunist production), Canada (12 percent), Japan (9 percent), Norway (7 percent), France (5 percent), and West Germany (4 percent).

Aluminum is produced from alumina by electrolytic reduction, using either the prebaked or the Soderberg anode system. There are substantial economies of scale in aluminum production, with the most efficient scale

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[1]Full data on these costs are presented in Chapter 2 of this report.

being in the range of 75,000-100,000 tons per year. Initial capital costs are usually over $100 million. Average costs of production of an efficient aluminum smelter were estimated in 1966 to be about $418 per ton or $0.21 per pound, assuming normal capacity utilization. In 1970 dollars average costs would be about $507 per ton or about $0.25-0.26 per pound. Short-run variable costs (including alumina) were estimated to be almost $300 per ton (or $0.15 per pound); in 1970 dollars these costs would be about $0.18-0.19 per pound.

The minimal initial capital cost of an integrated bauxite-alumina-aluminum operation is at least $150 million, and may be as much as $1 billion. For integrated producers, average variable costs and marginal costs are fairly constant up to capacity, but increase rapidly as rated capacity is approached; in the long run average and marginal costs are relatively constant for a firm with access to commercial bauxite deposits. Capital costs constitute a high percentage of average production costs of an integrated producer -- the capital charges for one ton of aluminum are over one-third of long-run average production costs.

Demand for Aluminum

Aluminum has a variety of properties that make it a very versatile material. Its distinguishing characteristics are its light weight, strength, and natural attractive appearance. In addition, many aluminum alloys possess the tensile strength of steel while retaining the light weight of aluminum.

Consumption of aluminum in the noncommunist world grew very rapidly in the postwar period, increasing

from 1.484 million short tons in 1949 to 9.513 million short tons by 1968.[1] Aluminum consumption, particularly in the United States, is characterized by rapid growth in years of economic growth and substantial declines in consumption in years in which economic growth declines (such as 1956-1957, 1958-1959, 1965-1966, and 1969-1970). Between 1960 and 1969 world consumption grew at a rate of about 10 percent per year. The largest consuming nations in the world are the United States (49 percent of total noncommunist consumption in 1968), Japan (10 percent), West Germany (9 percent) and the United Kingdom (7 percent).

In 1946 the largest single end-use market for aluminum in the United States was building and construction, which accounted for 29 percent of total U.S. consumption. "Other" applications (including defense) accounted for 28 percent of the total, followed by consumer durables (13 percent), transportation (9 percent), electrical (8 percent), and containers and packaging (3 percent). The fastest growing end-use markets in the postwar period have been transportation, electrical applications, and containers and packaging. The end-use consumption patterns in foreign countries are substantially different from those in the United States. In particular, transportation has a much bigger share of the market, while building and construction has a much smaller share of the market than in the United States.

The characteristics of the demand for aluminum vary substantially in the different end-use markets.

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[1]These data measure mill product shipments to consumers, and therefore include aluminum recovered from scrap.

In building and construction, aluminum competes with a wide variety of materials, including steel, wood, copper (for plumbing, tubing, roofing, and gutters), and plastics. In the automotive market (which accounts for 40 percent of aluminum usage in transportation) aluminum competes with copper, iron and steel, plated zinc die castings, and plastics, while in aircraft (which accounts for 25 percent of the transportation market) aluminum competes to some extent with steel and titanium. In electrical and communications equipment aluminum competes actively with copper and steel (in towers and support structures). In containers and packaging, aluminum competes with tin plate, plastics, and tin-free steel. In consumer durables aluminum competes with copper, steel, fiberglass reinforced plastics and magnesium. Finally, in machinery and equipment aluminum competes with copper, nickel, steel, and plastics.

It appears that within realistic price ranges aluminum will neither gain nor lose any important markets in the next 5 to 10 years. Aluminum will probably continue to increase its market share in the "traditional" applications, particularly construction and electrical applications. The most important potential new markets for aluminum are in automobile engine blocks, automobile radiators, desalination plants, and cryogenics. However, none of these applications are imminent and none would represent a revolutionary increase in aluminum sales.

An econometric analysis of the aluminum industry performed by Charles River Associates reveals that the U.S. long-run demand elasticity for aluminum with respect to price is about -1.6, indicating that a 10 percent increase in aluminum prices will lead to a 16 percent decrease in aluminum consumption. (See Table 3-2 and the accompanying text.) The decline in consumption would

be greatest in transportation, electrical applications, building and construction, and machinery and equipment and least in consumer durables, containers and packaging, and "other applications (including defense). The short-run elasticity is only about -0.30, indicating that a 10 percent increase in aluminum prices would lead to only a 3 percent reduction in consumption in the first year. The long-run elasticity of demand with respect to copper is about -0.36, indicating that a 10 percent *increase* in copper prices will lead to a 3.6 percent *increase* in aluminum consumption. Virtually all of this substitution occurs in electrical applications.

The econometric results also suggest that in the absence of changes in aluminum and copper prices, aluminum consumption over the next 3 to 5 years should grow at higher rates than the economy as a whole.

Industrial Organization

The aluminum industry is highly concentrated at each of the three principal stages of production. Six vertically integrated firms account for almost four-fifths of noncommunist aluminum capacity. These firms are Alcan (19.2 percent), Alcoa (19.0 percent), Reynolds (11.3 percent), Kaiser (10.9 percent), Péchiney (9.1 percent), and Alusuisse (5.0 percent). If the capacities of several large additional firms (such as Ormet and Harvey) are included this figure approaches five-sixths of total aluminum capacity. In addition government-owned firms in protected markets account for about 4 to 5 percent of total capacity. If the capacities of these firms are excluded from the total, the combined

aluminum capacity of the top seven or eight firms in the industry is about 90 percent of total noncommunist capacity serving international markets. Bauxite mining and aluminum production are even more concentrated than aluminum production.

The most important entry barriers for integrated production are probably economies of scale (the minimal efficient scale of an integrated operation is currently over 3 percent of the noncommunist market), access to a high-quality bauxite deposit, and the large initial capital investment necessary for low-cost production.

Although a number of new firms have announced their intention of entering the aluminum industry in the next few years (a full list can be found in Chapter 4 of this report), the only important new entrant is American Metal Climax (AMAX), which has recently acquired large commercial bauxite reserves in Australia. If all of the planned capacity construction by new firms occurs on schedule and if no major new projects are initiated by the established producers, the market share of the six principal integrated firms would decline from 76.6 percent in 1970 to 61.9 percent in 1971. The actual decline in industry concentration will of course be much less than this.

The profit rates of the major aluminum companies have been relatively low in recent years. However, in absolute terms the major integrated firms are all huge by almost any standards; in 1970 the combined after-tax earnings of Alcoa, Kaiser, Reynolds, Anaconda, and Harvey was $256 million, while the combined stockholder's equity was $3.904 billion. It should also be noted that without exception the smaller aluminum producers are all owned by large, well-established firms.

. Aluminum Prices

Very little elemental aluminum is sold in the form of bauxite and alumina. Somewhat less than one-tenth of U.S. sales of primary aluminum are in the form of hot metal (primarily to the automobile industry), about one-third of U.S. sales are in the form of primary ingot, and the balance is in the form of fabricated and semi-fabricated products. An examination of the available data on mill product prices suggests that these prices follow the general movements in the price of ingot.

The list price of primary ingot is changed on the average about twice a year. The general pattern in the postwar period has been for one firm (usually Alcoa, Alcan, or Kaiser) to initiate a change in the list price and for the other firms to follow within a few days. Frequently the list price does not represent actual transaction prices for much of the market. In times of shortage (such as most of the period from 1948 to 1956) the primary producers ration aluminum. In these times the prices of black market aluminum and of scrap aluminum (a close substitute for primary aluminum in some applications) rise sharply. During times of surplus (such as from 1958 to 1960 and from 1969 to the present) the primary producers discount from list price.

Between 1947 and 1957 both list and transaction prices of aluminum increased, with the list price going from $0.15 per pound in 1947 to $0.281 in August 1957. The list price fell to $0.225 by 1963 and then increased to its present level of $0.29. Transaction prices, as represented by scrap prices, have fallen significantly

during the past two years and are currently reported to be as low as $0.22 per pound.

A comparison of the list price data with CRA's index of aluminum costs of production shows that the markup between list price and long-run average cost has remained remarkably stable in the postwar period. Transaction prices in the long run tend to follow closely the list price, but in the short run there is a very significant correlation between the extent of discounting in the primary market and the capacity-utilization of the primary producers.

Thus, the processes generating list prices and transaction prices in the aluminum market are different. The list price is determined primarily by trends in long-run average costs and by other long-run factors, although it is also influenced by short-run factors. Marginal transaction prices are determined during times of surplus by the extent to which the primary producers discount ingot. The extent of discounting is in turn determined by the extent of excess capacity in the market. In times of shortage, marginal transaction prices are determined by competitive forces -- the price increases until the supply from secondary producers and marginal primary suppliers equals the excess demand of consumers being rationed by the primary producers.

Government Policies

At the present time the most important government policies affecting the aluminum market are those concerned with the wage-price freeze, trade policies, and the stockpile disposal program.

Slightly over 830,000 tons of aluminum are currently available for disposal by the government. This material

is currently being sold under four-year contracts with primary producers. The producers must purchase about 379,000 tons during the next two years. The remaining aluminum (about 452,000 tons) will probably be sold over the next six years. These government sales, while large in absolute value, are not likely to have a significant effect on the aluminum market. The average sale rate over this period, even if all the stockpile excess is sold, will be only about 3 percent of U.S. consumption and less than 2 percent of world consumption.

Most countries impose low or zero tariff rates on bauxite, alumina, and aluminum ingot -- the products that represent the bulk of international trade in aluminum. Prior to the surcharge, U.S. duties on unprocessed aluminum tended to be quite low (e.g., the tariff on aluminum ingot was $0.01 per pound). The 10 percent surcharge announced on August 15, 1971 represents additional duties of about $1 per ton on bauxite, $0.02-0.03 per pound on aluminum ingot and more than $0.03 per pound on more processed forms of aluminum.

The wage-price freeze of August 15, 1971 set ceilings on the actual transaction prices at which aluminum may be sold. The Treasury ruled, however, that prices could not be frozen at levels lower than those prevailing on May 25, 1970. As the transaction prices of virtually all aluminum products were substantially greater on that date than in August 1971, the price freeze had little effect on the aluminum market. The wage freeze also had little effect, as the new aluminum labor contract had already taken effect before the freeze was announced. Similarly, the current system of wage-price controls will not have any significant direct effects on the aluminum market.

The Aluminum Industry in the United States

Most of the bauxite and much of the alumina consumed in the United States is imported, while only a relatively small percentage of aluminum is imported. Even smaller quantities of mill products are imported. As the value added in aluminum production is substantially greater than in bauxite and alumina production, the aluminum stage of the manufacturing process has the greatest impact on the U.S. economy.

In 1970, U.S. production of bauxite was only about 2.2 million tons, or less than 4 percent of total non-communist production. Virtually all of this production was in two counties in Arkansas. Bauxite mining in the United States has been a relatively stagnant industry in recent years.

U.S. alumina capacity in 1969 was 6.8 million tons, while imports (primarily from Australia and Surinam) totalled 1.9 million tons. There are only nine alumina plants in the United States: three in Louisiana, two in Arkansas, two in Texas, one in Alabama, and one in the Virgin Islands. There has been a pronounced trend in recent years to locate alumina facilities near bauxite mines.

In 1970 total U.S. primary aluminum ingot production was 7.592 million pounds; primary ingot imports (primarily from Canada) were 0.700 million pounds and primary ingot exports primarily to Europe and Japan were 0.817 million pounds.

Aluminum reduction plants are located in two broad areas in the United States: a cluster in the Pacific

Northwest and a band from Southwest Texas to northern New York State. The smelters in the Pacific Northwest are located near cheap sources of hydroelectric power. The smelters in Arkansas, Texas, and Louisiana are located in areas that are accessible to either domestic or imported bauxite and to sources of natural gas. The remaining plants are largely located in the Tennessee Valley, the Ohio River Valley, and near the St. Lawrence Seaway, all of which have low-cost power and easy access to major industrial markets.

There does not seem to be any marked variation among different firms or plants in costs of production. Of the 29 aluminum smelters in the United States, 10 were constructed during or before World War II; however, most of these smelters have been modernized over the years, as there is no way of knowing how out-dated any particular smelter is. A few of these 10 smelters may be approaching the end of their economic lives and the pollution controls may cause these smelters to be prematurely closed down.

The smelters in question are owned by the three major integrated producers in the United States, but no one firm is dependent on these old, possibly high-cost smelters for all of its output. Five of these smelters are located in the Pacific Northwest and the rest are scattered throughout the South and the Midwest.

Effects of Pollution Controls on the Aluminum Market

As Table 8-1 and 8-2 in Chapter 8 of this report indicate,[1] it is estimated by EPA that between 1972 and 1977 the investment costs of air pollution controls at aluminum smelters will

[1] Reproduced here for convenience.

Table 8-1

COST OF CONTROLLING PARTICULATE EMISSIONS
AT ALUMINUM SMELTERS
(Millions of August 1971 Dollars)

Investment Outlays	1972	1973	1974	1975	1976
Existing facilities	35.7	71.3	245.5	258.2	71.3
New facilities	42.0	42.0	42.0	42.0	42.0
Total	77.7	113.3	291.5	327.2	113.3
Annual Costs					
Operating and maintenance	8.6	21.0	53.1	89.1	101.5
Interest	4.6	15.8	46.2	85.0	92.3
Depreciation	3.2	9.7	32.1	57.7	64.2
Total	16.4	44.5	133.4	229.8	258.0
"Total" Costs					
Total cash costs[1]	90.0	148.1	390.8	499.3	307.1
Total deductions[2]	86.3	134.3	344.6	416.3	214.8

[1] Investment costs plus annual costs minus depreciation.

[2] Total cash costs minus interest.

SOURCE: Council on Environmental Quality.

NOTE: The following assumptions were made in deriving the cost estimates:

1. Only particulate fluorides are controlled.
2. All control equipment will have to be replaced.
3. The interest rate is 10 percent.
4. Capacity will grow at 5.25 percent per year.
5. Production will grow at 5.8 percent per year.
6. The depreciation rate is 7 percent.
7. There is no down time.
8. Costs of controlling power emmission and costs of auxiliary facilities may increase costs by 25 percent.

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Table 8-2

COSTS OF WATER POLLUTION ABATEMENT
AT U.S. ALUMINA FACILITIES
(Millions of August 1971 Dollars)

Investment Outlays	1972	1973	1974	1975	1976
Existing facilities	26.42	28.03	29.68	31.37	33.11
New facilities	12.50	13.23	14.03	14.84	15.72
Total	38.92	41.26	43.71	46.21	48.83
Annual Costs					
Operating and maintenance	.87	1.78	2.70	3.66	4.63
Interest	3.14	6.38	9.68	13.06	16.54
Depreciation	1.57	3.18	4.84	6.53	8.27
Total	5.58	11.34	17.22	23.25	29.44
"Total" Costs					
Total cash costs[1]	42.93	49.42	56.09	62.93	70.00
Total Direct Costs[2]	39.79	43.04	46.41	49.87	53.46

[1]Investment costs plus annual costs minus depreciation.

[2]Total cash costs minus interest.

SOURCE: Council on Environmental Quality.

NOTE: The following assumptions were made in deriving these cost estimates:

1. In 1971 the industry had invested approximately $117 million (in August 1971 dollars) of the $212 million required to attain water pollution control standards.
2. The interest rate is 10 percent.
3. The growth rate is 5.8 percent.
4. The depreciation rate is 5 percent.
5. For down-time, the installation multiple is 1-5.

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total $713 million and the investment costs at alumina plants will total $219 million. These outlays are huge in absolute terms by almost any standards, and an expenditure of this magnitude by the industry will adversely affect the already low rates of return of aluminum producers. However, the aluminum producers appear to have the financial resources to raise capital sums of this amount. In addition the actual reduction in net revenues will be less than the actual control costs, as some of these costs will be recouped through higher prices to consumers, as reduced gross profits will result in lower tax liabilities, and as special tax incentives will further reduce after-tax costs (see Chapter 8).

The annual cost of abatement, defined to equal operating and maintenance costs of abatement equipment, interest and depreciation, represents the relevant long-run costs to producers of installing and maintaining a given level of abatement facilities. It is this cost that producers would have to recover (per pound of ingot) if their profits were to be unaffected.

The combined annual costs per pound of both air and water pollution abatement reach a maximum of $287.44 million dollars by 1977, or $0.025 per pound in the base estimate, although these costs may be as low as $0.020 or as high as $0.032 per pound.

The current weak conditions of the aluminum market are caused by the joint effects of a decline in demand caused by the U.S. economic recession and a simultaneous increase in capacity induced by the rapid growth of

demand during the 1960's. In the absence of pollution controls, U.S. aluminum consumption over the next 5 to 10 years can probably be expected to grow at a rate of 6-10 percent per year, assuming that U.S. industrial production recovers to a growth rate of 4-5 percent per year. The list price over this period can be expected to remain fairly stable in real terms. Transaction prices of aluminum, which are now as much as 25 percent below the list price, can be expected to approach the list price over the next two to three years and thereafter should follow the list price fairly closely.

The effects of controls on the aluminum market depend on the assumptions made about controls on other industries, the timing of the controls, and U.S. trade policies. Assuming for the moment that the timing of the controls is as estimated by EPA and that there is no 10 percent import surcharge or equivalent trade protection, the list price of aluminum will increase in proportion to the cost increase. Under the middle cost assumption, if controls are imposed only on the aluminum industry U.S. consumption of aluminum in 1977 would be about 4-5 percent below what it otherwise would be and transaction prices would be about 6-7 percent above what they otherwise would be.[1] In the long run, transaction prices would be about 10 percent higher and U.S. consumption would be about 16 percent lower than the levels they would otherwise attain.

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[1]Using the range of costs estimated by EPA, the effect on U.S. consumption is between 3 and 6 percent and the effect on transaction prices is between 5 percent and 8 percent.

In absolute terms, if we assume an 8 percent growth rate for aluminum consumption without controls, consumption would grow from 8.9 billion pounds in 1970 to 15.3 billion pounds in 1977 and 22.5 billion pounds by 1982. With controls, consumption in 1977 and 1982 would be 14.6 and 18.9 billion pounds, representing declines of 0.7 and 3.6 billion pounds respectively.

Controls on other industries will alter these results to some extent. The effects of copper industry controls on the aluminum market would be negligible over the next five to six years. By 1982, however, controls on copper would have the effect of increasing aluminum consumption by 2.9 percent. That is, with controls on the aluminum industry alone, consumption of aluminum would be 16 percent lower than it would be with no controls, but if the copper industry is also controlled aluminum consumption would be only 13.1 percent lower.

Controls on power costs would increase aluminum production costs by as much as one-sixth as much as the direct controls on aluminum. If this occurs, the results of our calculations would also be increased by as much as one-sixth. It should be pointed out, however, that the higher end of the range of the estimated control costs is supposed to include the possible effects of controls on power. Finally, controls on other competing materials will reduce the adverse effect of the controls on aluminum. It is unlikely, however, that the prices of steel, plastics, zinc, wood, and all other competing materials would increase by as much as aluminum costs as a result of pollution controls. These issues are discussed at greater length in Chapter 8 of this report.

Even with controls, U.S. aluminum production will in the future probably grow at about the same rate as U.S. consumption, although this conclusion is by no means certain. The controls will probably not cause any existing smelters to be shut down, although some of the older prewar smelters, which are nearing the end of their economic life, might be shut down prematurely. The estimated control costs, however, are just high enough to offset the transportation and tariff costs of locating new smelters abroad and exporting to the United States. If this occurs, U.S. production would not decline from its current rate but within the next 10 years the share of U.S. production in the U.S. market would begin to decline.

Pollution controls will probably have little effect on U.S. alumina and bauxite production. Even without controls, new alumina facilities would probably be located near foreign bauxite mines. U.S. bauxite production accounts for only a small percentage of U.S. bauxite consumption and has been declining gradually during the postwar period.

The effects of the controls on employment will be roughly proportional to the effects on production. Employment will not decline as a result of controls, but it will grow more slowly than it would without controls. Rough calculations indicate that 10 years after the controls are imposed, aluminum employment would be about 10,000 persons less than if there were no controls.

The net cost to producers of the controls is less than the direct costs of the controls, as some of these costs will be recouped through higher prices. We

estimate that the before-tax net cost, defined as the reduction in before-tax net revenues of aluminum production, will be approximately $100 million per year. The after-tax net cost will be approximately in the range of $40-50 million per year.

As a result of the controls, we would expect some decline in U.S. exports of ingot and mill products, currently worth over $300 million per year, and some increase in U.S. imports of mill products, currently worth about $50 million per year. The exact extent of this effect depends on whether the control costs are great enough to induce new smelters serving the U.S. market to be located abroad. If this does not occur, the balance of payments effect will primarily consist of an eventual substantial decline (say $100-200 million) in the value of aluminum exports. If this does occur, we would expect the value of U.S. aluminum imports eventually to increase substantially as well, although this effect would probably not be felt until 5 to 10 years after the imposition of the controls.

The effects of the controls on different regions of the country will primarily consist of a slower rate of growth in investment in aluminum facilities than would otherwise occur; there will probably not be an actual decline in aluminum production or employment in any region. The impact of slower growth rates will occur primarily in those regions that traditionally have accounted for most U.S. aluminum production: the Pacific Northwest and the Midwest (including the Gulf Coast, the Ohio River Valley, and areas served by the Tennessee Valley Authority).

The major impact of the controls will clearly be on the domestic aluminum smelting industry. Production of aluminum mill products will also be adversely affected, as the total market for aluminum mill products will grow more slowly as a result of the controls. The remaining effects on suppliers and consumers are too diffuse to be isolated.

The foregoing results are completely dependent on the assumptions that the timing and level of the control costs will be as estimated by EPA and that there will be no compensating trade protection. If the control expenditures are greater than forecast, or if the bulk of the expenditures must be made during the next two or three years, the effects on the industry may be much more severe than we have estimated.

The analysis of the effects of the controls was made on the assumption that the 10 percent surcharge would not continue and that there would be no equivalent revaluation of currencies. The current 10 percent tariff surcharge on imports of aluminum almost exactly offsets the increase in production costs resulting from pollution controls. Maintenance of the surcharge would therefore eliminate the incentive to locate smelter capacity abroad and would substantially moderate the adverse effects of controls on the balance of payments.

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Charles River Associates
for the
Council on Environmental Quality

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